MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2017/2018

EEN1016 – ELECTRONICS I
(TE, RE)

11 OCTOBER 2017
9:00 a.m – 11:00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of **5** pages excluding cover page with **4** Questions only.

2. Attempt **ALL** questions in the Question Paper. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

QUESTION 1

a) Calculate the mobility and diffusion constant for electrons in a Gallium Arsenide (GaAs) if the mean lifetime for electrons is $3.58\times10^{-9}\,s$ at room temperature. The following information are known:

$$\text{Electron charge, } q = 1.602\times10^{-19}\,C$$
$$\text{Electron effective mass, } m_n^* = 0.6103\times10^{-31}\,kg$$
$$\text{Boltzmann constant, } k = 1.3806\times10^{-23}\,JK^{-1}$$
$$1eV = 1.602\times10^{-19}\,J$$

[8 marks]

b) A sample of high-purity intrinsic Germanium (Ge) has an intrinsic carrier concentration of $2.54\times10^{21}\,m^{-3}$ at room temperature. Arsenic (As) impurities are doped into the sample to make it into n-type which contains 1×10^{23} ionized donors per cubic meter. Given the following information:

$$\text{Electron charge, } q = 1.602\times10^{-19}\,C$$
$$\text{Atomic number density of Ge} = 4.42\times10^{28}\text{atoms m}^{-3}.$$
$$\text{Mobility of free electrons in the intrinsic material } \mu_n = 0.39m^2V^{-1}s^{-1}$$
$$\text{Mobility of free holes in the intrinsic material } \mu_p = 0.19m^2V^{-1}s^{-1}$$
$$\text{Mobility of free electrons in the doped material } \mu_n = 0.36m^2V^{-1}s^{-1}$$
$$\text{Mobility of free holes in the doped material } \mu_p = 0.18m^2V^{-1}s^{-1}$$

Determine the followings:

(i) Impurity concentration level in ppm (parts per million)

[2 marks]

(ii) Electron concentration in the intrinsic material

[1 mark]

(iii) Hole concentration in the intrinsic material

[1 mark]

(iv) Conductivity of the intrinsic material

[2 marks]

(v) Approximate electron concentration in the doped material

[2 marks]

(vi) Conductivity ratio of the intrinsic material to the doped material.

[3 marks]

Continued ....

c) Determine the electron configurations of sodium (Na, atomic number $Z = 11$) and copper (Cu, atomic number $Z = 29$). What is the common factor between the two materials?

[6 marks]

QUESTION 2

a) A $6.8V$ Zener diode is used for voltage regulation in the circuit shown in Figure Q2(a). The supply voltage, V_s can vary between $10V$ to $15V$. The minimum load current is $0mA$. The minimum Zener diode current is $1.5mA$. The power dissipation of the Zener diode must not exceed $700mW$ at room temperature. Determine the followings:

(i) Maximum permissible value of Zener diode current I_{ZM}.

[2 marks]

(ii) Value of R_s that limits the Zener diode current to the value determined in part (i).

[3 marks]

(iii) Maximum load current.

[3 marks]

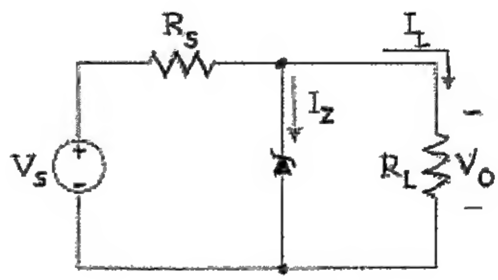

Figure Q2(a)

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b) A half wave rectifier with a capacitor filter is shown in Figure Q2(b). V_s is 120V in root mean square (RMS) format at 50 Hz, $C = 1000\mu F$ and $R_L = 1k\Omega$. Voltage drop across conducting diode is 0.7V. Calculate the followings:

(i) Maximum output voltage $V_{0\max}$.

[4 marks]

(ii) Maximum output current $I_{0\max}$.

[2 marks]

(iii) Average output voltage V_{0dc}.

[2 marks]

(iv) Ripple voltage.

[2 marks]

(v) Ripple factor.

[2 marks]

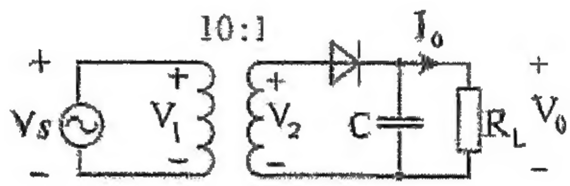

Figure Q2(b)

c) You are given a 230V AC supply. You are required to generate 10V DC with very low ripple. Identify the various components you need. Explain why they are needed and interconnect them appropriately.

[5 marks]

Continued ....

QUESTION 3

A bipolar junction transistor (BJT) circuit is shown in Figure Q3. Given that $V_{BB} = 8V$, $R_B = 50k\Omega$, $V_{CC} = 15V$, $R_C = 2k\Omega$, $R_E = 2k\Omega$ and the DC current gain ratio, β of the BJT is 100. Assume the forward biased base to emitter voltage, $V_{BE(ON)} = 0.7V$.

(i) Calculate all node voltages (V_B, V_C, V_E) and branch currents (I_B, I_C, I_E) via DC analysis.

[14 marks]

(ii) Indicate the region of operation of this BJT circuit with justification.

[5 marks]

(iii) Determine the maximum value of R_C for which the BJT is still operate in the region as mentioned in (ii).

[6 marks]

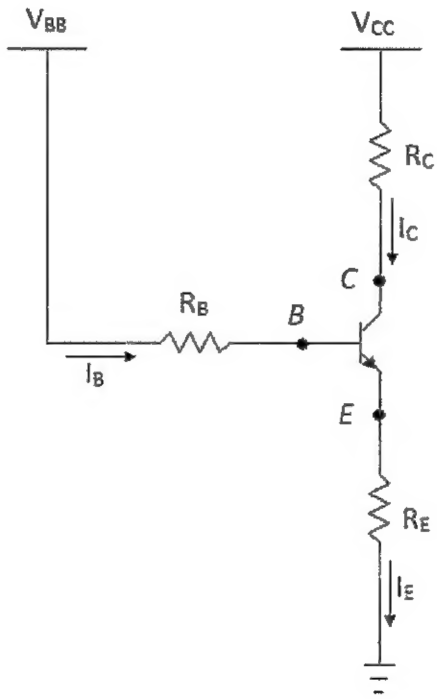

Figure Q3

Continued ....

QUESTION 4

Figure Q4 shows a common emitter configured BJT amplifier circuit. Given that $R_S = R_C = 10k\Omega$, $R_F = 200k\Omega$, $R_E = 5k\Omega$, $C_1 = C_2 = C_3 = 1\mu F$ and hybrid h parameters as follows:

$h_{ie} = 1.1k\Omega$ $h_{fe} = 60$ $h_{oe} = 0.1mS$ $h_{re} = 0$

(i) Draw the complete hybrid h small signal circuit by applying the Miller's theorem. All components in the circuit must be properly labelled.

[8 marks]

(ii) Derive the expression of R_{out} and calculate its value.

[6 marks]

(iii) Derive the expression of R_{in} and calculate its value.

[11 marks]

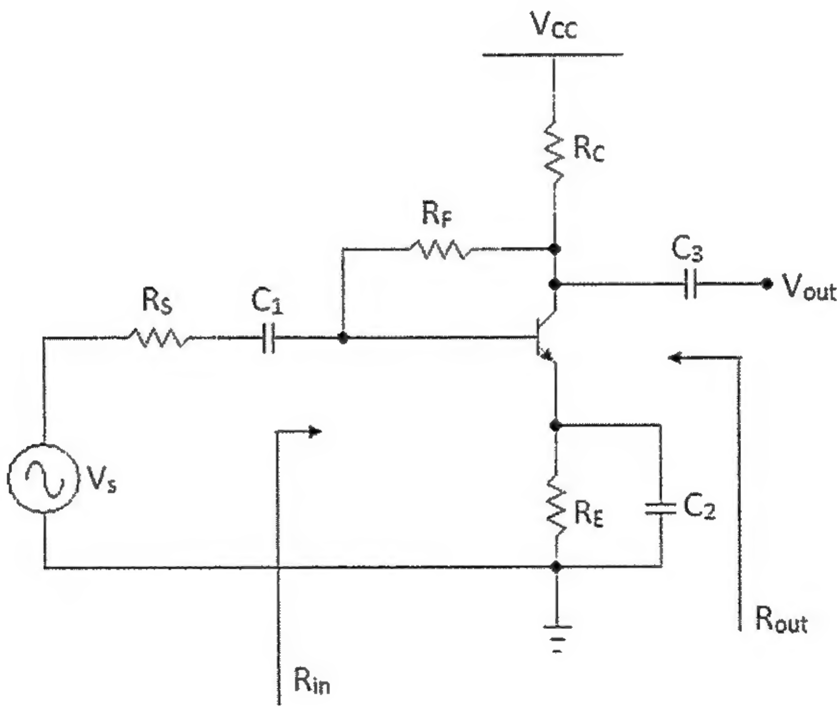

Figure Q4

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